A distinct species, of which I have one male specimen obtained in Surinam by Mr. C. W. Ellacombe. It has the coloration and facies of *Mechanitis polymnia*, of which it is no doubt a homœochromatic associate.

Napeogenes eunomia, sp. n.

Alis diaphanis, venis et marginibus nigris, punctis submarginalibus albis; posticis marginem internum versus pallide sulphureo tinctis: subtus ut supra, sed punctis submarginalibus albis.

Hab. N. Peru (*Krause*).

I have a single male specimen from Bates's collection which has for a long time remained unnamed. In general coloration it resembles *Ceratinia frater*, but the black margins are narrower and the venation is quite different.

Napeogenes amara, sp. n.

Napeogenes tolosa, G. & S. Biol. Centr.-Am., Rhop. i. p. 27, tab. iii. fig. 4 (partim).

N. tolosæ similis, sed colore nigro apicali basin versus magis extenso maculisque apicalibus flavis minoribus.

Hab. Nicaragua, Costa Rica, Chiriqui.

Since writing on *N. tolosa* in the 'Biologia' a large series of this insect has been received from Guatemala and Chiriqui. The authors pointed out that specimens from southern localities were darker than those from Mexico and Guatemala, but with the material then available they hesitated to separate them. The large series I now have leads me to think the differences are sufficiently great to warrant me in describing the Nicaraguan and southern form as distinct, and I have therefore named it *N. amara*.

XXIII.—*On the probable Mode of Formation of the Fusion between the Femur and Trochanter in Arthropods.* By Edmond Bordage *.

In the present communication it is my intention to show what in my opinion are the causes which must have brought about the fusion of the trochanter and the femur in the Phasmidæ. The explanation that I am about to give may, I

* Translated by E. E. Austen from the 'Comptes Rendus Hebdomadaires des Séances de la Société de Biologie,' t. v. no. 28, 5 août, 1898, pp. 839–842: from a separate impression communicated by the Author.

think, be applied to all those Arthropods which exhibit this fusion of the second and third joints of the thoracic limbs, accompanied by the persistence of a groove constituting a *locus minoris resistentiæ*, admirably adapted for ensuring the process of autotomy.

While following attentively the phenomenon of ecdysis, I have been struck by the violent efforts that Phasmids have to make in order to free themselves from their old chitinous envelope. These clumsy Orthoptera, embarrassed by their long legs, do not always succeed in doing so—a failure which is evidently the cause of their subsequent death. At other times they are obliged to make a sacrifice of one or several of their limbs; the latter, always becoming detached at the groove which corresponds to the line of fusion of the femur and trochanter *, remain fixed in the old envelope with which they are shed.

I have been able to observe that out of 100 specimens of *Rhaphiderus scabrosus* which were kept in captivity and protected from all enemies, 9 had perished through being unable to disengage themselves from their old envelope, and that 22 had survived after having sacrificed one or several of their legs (the 69 others accomplished all their ecdyses without mutilations). We see, then, that 31 per cent. of the Phasmids perished or were mutilated through the ecdyses, a figure which I think must sometimes be exceeded. We may judge, therefore, of what must have happened when the disposition which ensures autotomy was non-existent or had not yet acquired the perfection which it exhibits at the present day.

The efforts which the insect is obliged to make in order to disengage itself may in certain cases last for an entire day, and are repeated eight times at least during its existence †. The violent strains which result therefrom affect especially the region of the trochanter and the upper extremity of the femur. I am led to believe that we must regard this mechanical action as one of the principal causes of the fusion of the trochanter and the femur. It is certain that this fusion has not always existed, and that there have been among the ancestral forms belonging to the existing Phasmids insects in which there was a genuine articulation between these two consecutive segments. There has therefore taken place in

* This mutilation is evidently a form of autotomy, which in this case we might term *exuvial* (from *exuviæ*, sloughed skin). The regeneration which ensues always produces a tetramerous tarsus.

† Although I have not yet had an opportunity of noting the exact number of the ecdyses, I have nevertheless been able to remark that this number amounts at least to eight.

them later on a veritable phenomenon of anchylosis, bringing about the fusion in question. This is the hypothesis which is adopted by certain authors * in order to explain how, in the case of Vertebrates, articulations may become anchylosed in consequence of severe and repeated tensions and strains †.

The violent strains to which the limbs are subjected at the period of the ecdyses must have had an influence so much the more marked and so much the more efficacious in that at this moment the tissues are in an altogether peculiar condition, and since the integumentary layer which will become the new cuticular covering after the shedding of the old envelope is then still soft. The mechanical action occasioned by the strains has easily produced the thickening, the more intense chitinization of the arthrodial membrane, and, in consequence, anchylosis, a condition which, remarkably enough, is precisely the most favourable for securing autotomy in the line of the groove of fusion, which constitutes a *locus minoris resistentiæ*. This condition must have been produced as early as the primary epoch in one of the ancestors with tetramerous tarsus of the existing Phasmids (see my communication of June 28, 1897, to the Académie des Sciences) ‡. The Stegocephali of this epoch were able to contribute to the perfecting of the disposition ensuring the autotomic process.

I would add that modifications in the manner of walking must have been produced at different intervals §—modifications which were themselves occasioned by variations in the general form of the body during the phylogenetic development. They have brought about displacements in the position of the points of support more or less distant from the body, with the object of ensuring the stability of the latter. I think that we must again regard this as a cause of strains and tensions, which have also contributed to the formation of the fusion with which we are dealing. In short, the way in which this special condition has been produced would be explained by the principles of the science which Prof. Giard terms *morpho-*

* See especially Tornier, "Das Entstehen der Gelenkformen," W. Roux's Archiv für Entwickelungsmechanik, 1895.

† In the articulations of Arthropod limbs the arthrodial membrane is compared to a *ligament* by H. Milne-Edwards. In the cases of anchylosis among Vertebrates the ligaments of the joints are precisely the parts which become ossified.

‡ Ann. & Mag. Nat. Hist. ser. 6, vol. xx. (1897) pp. 507–510.

§ These modifications obliging the limbs to be flexed, to be folded further back, or to extend themselves during locomotion, according to circumstances.

dynamics, Prof. Delage *biomechanics*, and W. Roux the *mechanics of development* (*Entwickelungsmechanik*).

The Arthropods in the case of which we observe, either in all the thoracic limbs or in only a single pair, the fusion of two consecutive joints, which ensures autotomy*, appear among those the growth of which takes place by means of ecdyses, during which these animals often have much difficulty in freeing their limbs from the old cuticular envelope, because these members are very long, are terminated by enormous pincers (lobster, crabs), or are provided with large foliaceous adornments (leaf-insects) †. It is probable that in these different cases the mechanical actions produced at the moment of ecdysis must have contributed in a large measure to the development of the peculiar structure in question. I shall shortly publish a detailed study on the Arthropods in which this is found.

In the Phasmids the phenomena of autotomy must have already begun to appear before the complete fusion of the femur and trochanter, the articulation corresponding to these two joints then constituting a *locus minoris resistentiæ*. At the outset many of these insects must have perished from the results of hemorrhage. Then, a perfecting process gradually setting in and being transmitted by heredity, the number of the survivors increased. The regenerative faculty must at first have been but slightly marked, and the first regenerations must have been very imperfect. Then, as the fusion between femur and trochanter tended to take place more and more, there was more regularity in the sections corresponding to the amputations, and, in consequence, more regularity in the portion reproduced, until the moment when regeneration was capable of furnishing a limb with a tetramerous tarsus, the joints of which were sharply differentiated one from another.

I therefore believe that this peculiar condition is to be regarded as an example of a character acquired by use, by functional excitation, and then transmitted by heredity, as fast as it advanced towards perfection.

My experiments upon the regenerations following artificial amputations lead me to suppose that an altogether special

* This does not imply that all the Arthropods in which autotomy is found to occur must necessarily exhibit fusion between two consecutive joints of their limbs.

† I have recently been able to remark phenomena of autotomy in leaf-insects which had been sent to me from the Seychelles. In these Orthoptera the fusion between femur and trochanter exists.

mode of selection has played a great part in the perfecting of the regenerated limb. I have been able to remark, in fact, that the regenerated portions were so much the more perfect according as the amputations had been performed with greater regularity and the hemorrhage had been less copious. When the limb is cut off somewhat obliquely, the result is a teratological regeneration with tarsal joints misshapen and but little distinct one from another. A limb so imperfect as this almost always becomes detached from the body at the next ecdysis. The same applies to the limbs mangled by the teeth of the enemies of the Phasmids. Here, then, we have a real selection effected by the ecdyses, and I propose for it the term *exuvial selection*.

XXIV.—*Further new Species of* Forficularia.

By Malcolm Burr, F.E.S., F.Z.S.

In the following paper four new *Forficularia* are described, of which three were taken in Ecuador by Mr. Rosenberg and the other in Java by Herr Frühstorfer. Two of the species from Ecuador will later require a new genus, but the material at hand is barely sufficient for the purpose. These two are considered by M. de Bormans, to whose examination I have submitted all the species described, to be identical; but several small characters, worth little in themselves, but of cumulative value taken together, have induced me to regard them as separate, though closely allied.

I take this opportunity of impressing collectors abroad with the necessity of packing earwigs with extreme special care, as I have at least a dozen novelties in my collection that I am unable to describe, as they are mutilated; for the slightest accident may destroy a valuable character. Of others also I possess only females, which it is highly undesirable to describe without the male.

The number of undescribed earwigs still existing in collections is probably very large; M. de Bormans has informed me that he alone has no less than sixty novelties.

I seize the occasion to express my thanks to this entomologist for the assistance he has very kindly rendered me in examining my types, communicating descriptions of sexes which I do not possess, and for much valuable information.

I have taken the measurements as follows:—of the body, from the mouth to the apex of the anal segment; of the